

HSL622: Assignment 1

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1 Problem statement

This is a classic puzzle which has been used as a toy problem in AI to demonstrate the working of symbolic approaches like production systems. You are given two jugs, one with a capacity of 7 litres and the other with a capacity of 3 litres. You have access to a water supply or tap which can be used to fill up these jugs, and the water in them can also be thrown away or poured from one jug into another. Your task is to measure out exactly 5 litres of water, using as many steps as needed.

2 What to do

Start by taking a look at the production system formulation of this puzzle which is provided in the paper at <http://web.iitd.ac.in/~sumeet/Thomas95.pdf>: see in particular the section titled ‘The Production System Approach’. Your task is basically to implement the production system laid out here, or at least a simplified version of it. You can use any programming language of your choice; but please write clear and well-structured code with comments so that it can be easily understood by someone else. And importantly, please structure and label your code such that **the implementation of the 3 components of the production system (global database, production rules, control structure) is clearly apparent in different portions of the code.**

2.1 Initial version: random search

[10 marks] To keep things simple, your initial implementation can just use a random search strategy. This means that the job of the control structure will simply be to randomly select one of the production rules that is applicable in the current state, and no other search strategy need be implemented. With this implementation, run your code 3 times and report how many iterations or steps it takes to reach the goal state. Does it always take the same amount of steps, or does it vary? Why?

2.2 Cleverer search

[5 marks, extra credit] This part is optional, but if you are able to do it you can earn some extra credit. Can you make the control structure more efficient by adopting some cleverer search strategy than just random search, to select the rule to apply at each step? Think about how a human would solve this puzzle using actual jugs and water, and what steps they would follow. Is there a way to try to bring the AI system closer to the way the human might decide on the sequence of steps to be followed?

If you manage to do an alternative implementation, run it 3 times as well, and compare how long it takes to reach the goal state, with the initial random search version. How much speed-up do you manage to achieve, and why do you think this happens?

3 What to submit

- Your code, which should just be a single code file for the random search case, and (if attempted) another file for the cleverer search case. These should be in a programming language of your choice, with clear structuring and commenting as mentioned. The code does not need to take any input from the user, as the initial state is always the same (both jugs empty). But the code should output the sequence of states which it scans through (*i.e.*, the contents of the global database at each step), and finally, it should print out how many steps it took to reach the goal state.
- A short report, where you document in text form how exactly you implemented your global database, production rule set, and control structure, for both cases if applicable. And then report the results of 3 runs as asked for above, and also answer the corresponding questions which have been posed above.

These files will need to be uploaded on Moodle; the opening of the submissions will be announced in due course. Please complete this assignment by the end of **Friday 22nd March**, to allow for sufficient time for one subsequent assignment.